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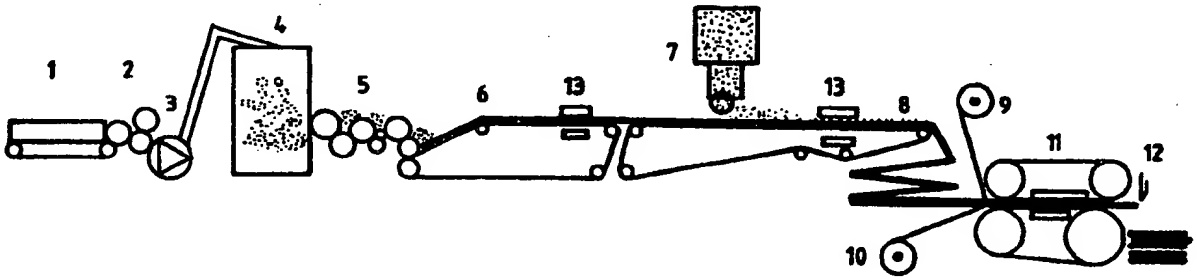

(57) Abstract

The present invention relates to a method of manufacturing a fiber reinforced plastics material by a dry forming method. By this method the fibers are opened by carding, a web is formed of the fibers, pulverous matrix is dosed onto the web, the layers of the web are superimposed by folding, the layered web is heated, pressed and cooled.

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METHOD OF MANUFACTURING A FIBER REINFORCED PLASTICS MATERIAL AND A PLASTICS MATERIAL PRODUCED BY THE METHOD

The present invention relates to a method of manufacturing a fiber reinforced plastics material by a dry forming method.

The problem in manufacturing fiber reinforced materials is often that bundles of the reinforcing fibers exist as the fiber bundle has not fully opened in the matrix and the fiber distribution is uneven. The fiber web is in most cases produced by preparing a water dispersion of the reinforcing fibers and the particulate plastics material and by filtering the water out. A disadvantage of this wet process is that the bonding chemicals are often washed out from the pretreated fibers in the dispersion stage.

The object of the present invention is to avoid such disadvantages. A web with improved fiber distribution is achieved by a dry method by carding open the fiber which produces an open, porous and bulky web. Due to the dry process, the selection of the chemical treatment of the fibers to suit the matrix is wider than with a wet process, as there is no danger of the bonding chemicals being washed away.

A product is achieved by the method of the present invention, which is more homogenous and, due to a better bonding, has more advantageous mechanical properties than a product produced by conventional methods.

The method of the present invention comprise the following steps:

- opening the fiber by carding
- forming a web of the fibers opened by carding
- dosing a pulverous matrix onto the formed web
- superimposing the layers of the web by folding
- heating, pressing and cooling the layered web.

Glass fiber is usually used as the reinforcing fiber. Handling of the glass fiber is rendered easier by mixing synthetic organic fibers with the glass fibers whereby internal web transport in the machine is easier. The synthetic fibers can be chosen

a) to be comprised of the same polymer as the matrix whereby they melt to the matrix when heated and form together a matrix. Suitable substances are for example polypropylene, polyester and polyamide,

b) not to melt when heated but to form with the glass fiber a part reinforcing the composite. Suitable substances are for example aramid fiber, carbon fiber or a fiber which has a remarkably higher melting point than the material of the matrix, e.g. polyester fiber in a polypropylene matrix.

The fibers can be treated in advance e.g. with peroxides, which make them behave in the forming process in a way which improves the flowability of the matrix and thus a better surface of the product is achieved.

The invention is described in more detail, by way of example, with reference to the accompanying schematic drawing.

Cut glass fiber and synthetic fiber are dosed in a belt scale 1 and precarded in a schredder 2. The fibers are transported by a fan 3 to a mixing vessel 4 in which they are mixed by means of an air flow, i.e. they are homogenized and the surface weight is adjusted. After this the fibers are further opened by a non-woven textile carding machine 5. A web 6 is formed of the treated fibers onto a Fourdrinier wire. After the web formation, pulverous matrix 7 is dosed between each fiber web layer by using vibration if necessary. The surface weight of the web is determined at point 13. The machine folds the thin layers to form a superimposed structure in a folding unit 8 whereby the desired surface weight is achieved and the matrix 7 is

evenly distributed in the depth direction. This web is heated e.g. in a double wire press 11 to a temperature higher than the melting temperature of the matrix, e.g. polypropylene to 190 to 200°C or polyamide to about 300°C. Thereafter the web is pressed and cooled under pressure and cut to sheets (12) of the desired size which can be formed into the required plastics products.

By applying prior to the press 11 a film of the same polymer as the matrix with an extruder or a finished film (9, 10) from a roller and heating it simultaneously with the web in the press 11, a fiber-free layer is produced which facilitates production of a good, smooth surface. So-called roving threads or fabric as well as various fiber webs, for example web made up of electrically conductive fibers can be added to the web between the layers at this point or earlier after the web formation.

The length of the glass fiber is preferably 8 to 30 mm and carding produces a porous web of 50 to 200 g/m^2.

5 to 20 % by weight synthetic organic fibers are added among the glass fibers.

Pulverous matrix is added between each fiber web layer in the correct weight proportion, normally 80 to 50 % of the total weight. All thermoplastics are suitable for this purpose.

The desired surface weight of the product, e.g. 2000 to 4000 g/m^2, is acquired at the folding unit.

The present invention provides a method of manufacturing a reinforced thermoplastic sheet with favourable fiber distribution. Due to the shortness of the fibers they are easily carried with the fluid matrix even into difficult forms such as reinforcing handles, where the strenght of the fibers is needed.

Example

Glass fibers, the length of which is 12 mm and into which 10 % by weight polypropylene has been added, are treated in a carding machine. After the web has been formed, polypropylene powder is strewn onto the web whereby the proportion of the reinforcing fiber is 30 % by weight. Then the thin layers of web are superimposed by folding which gives a surface weight of 3000 g/m^2. This web is heated to 190°C and pressed at the pressure of 2 bar, cooled and cut to sheets of the desired size. The sheets are formed into the desired products the tensile strength of which is 90 MPa, the elongation at break 2,5 %, the impact strength 55 charpy, the flexural strength 140 N mm^{-2}. the tensile modulus 4500 N mm^{-2} and the flexural modulus 5500 N mm^{-2}. The web can also be coated with polypropylene film if a very smooth surface is desired.

What we claim is:

1. A method of manufacturing a fiber reinforced raw plastics material by a dry method, characterized by the steps of
- opening the fiber by carding
- forming the web from the fibers opened by carding
- dosing pulverous matrix onto the formed web
- superimposing the layers of the web by folding
- heating, pressing and cooling the layered web.

2. A method as claimed in claim 1, characterized in that the layered web is laminated.

3. A method as claimed in claim 1, characterized in that the reinforcing material is glass fiber.

4. A method as claimed in claim 3, characterized in that the length of the glass fiber is 8 to 30 mm.

5. A method as claimed in claim 3, characterized in that synthetic organic fibers are used in addition to the glass fiber.

6. A method as claimed in claim 5, characterized in that 5 to 20 % synthetic fibers are added.

7. A method as claimed in claim 1, characterized in that the pulverous matrix is a thermoplastic polymer.

8. A fiber reinforced plastics material whenever produced according to any one of claims 1 to 7.

AMENDED CLAIMS
[received by the International Bureau
on 8 October 1990 (08.10.90);
original claim 3 cancelled; claim 1 amended; claim 2 unchanged;
claims 4-8 unchanged but renumbered as claims 3-7 (1 page)]

1. A method of manufacturing a glass fiber reinforced raw plastics material by a dry method, characterized by the steps of
- opening the glass fiber by carding
- forming the web from the glass fibers opened by carding
- dosing pulverous matrix onto the formed web
- superimposing the layers of the web by folding
- heating, pressing and cooling the layered web.

2. A method as claimed in claim 1, characterized in that the layered web is laminated.

3. A method as claimed in claim 1, characterized in that the length of the glass fiber is 8 to 30 mm.

4. A method as claimed in claim 1, characterized in that synthetic organic fibers are used in addition to the glass fiber.

5. A method as claimed in claim 4, characterized in that 5 to 20 % synthetic fibers are added.

6. A method as claimed in claim 1, characterized in that the pulverous matrix is a thermoplastic polymer.

7. A fiber reinforced plastics material whenever produced according to any one of claims 1 to 6.

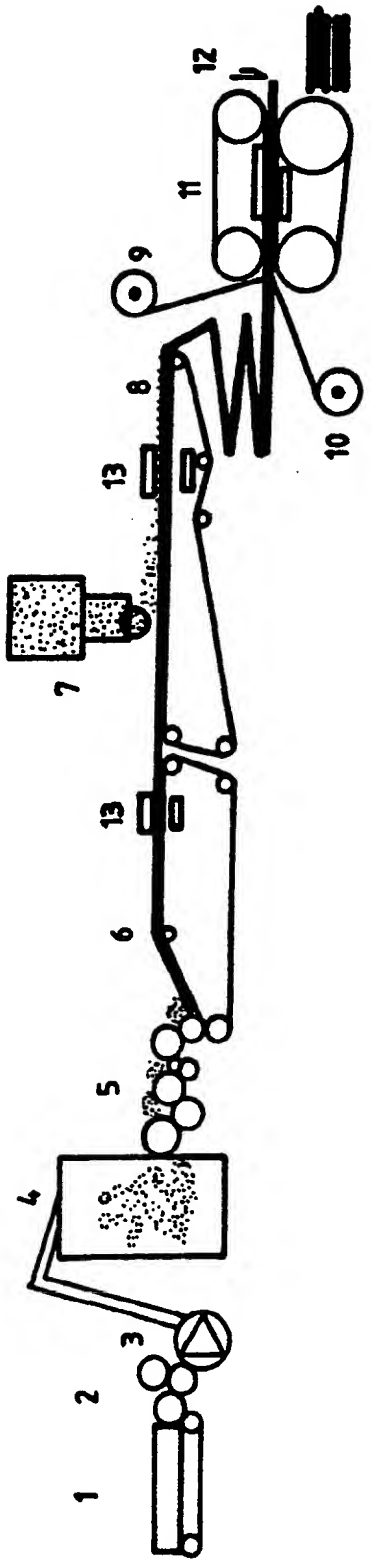

FIG 1

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 90/00131

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: D 04 H 1/60

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 28 B; B 29 C; B 32 D; D 04 H; E 04 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	US, A, 2671496 (M.A. CHAVANNES ET AL) 9 March 1954, see column 1, line 17 - line 55; column 2, line 1 - line 13 --	1,2,3,5, 7,8
Y	US, A, 4237180 (M.C. JASKOWSKI) 2 December 1980, see column 4, line 46 - line 68; column 5, line 1 - line 34 the claims --	1,2,3,5, 6,8
Y	CH, A4, 362044 (UNITED PLASTICS INDUSTRIES, INC.) 14 July 1962, see page 3, line 50 - line 91 the figures --	1,2,6,7, 8

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* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
29th August 1990	1990 -09- 03
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Åke T Larsson

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 90/00131

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the Swedish Patent Office EDP file on 90-08-02
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A- 2671496	54-03-09	DE-B-	1111933	00-00-00
		FR-A-	1149656	00-00-00
		GB-A-	787073	00-00-00
US-A- 4237180	80-12-02	NONE		
CH-A4- 362044	62-07-14	NONE		